Towards adaptive, dynamic and smart hyperspectral imager

Internship proposal
LAAS/CNRS
TOULOUSE, France

Context

While three spectral channels are enough to generate an image acceptable for the human eye, there are many applications for which having only the red, green and blue content of an image is insufficient. Hyperspectral imagers give access to many spectral bands on any pixel of an image, providing way more information that traditional RGB imagers.

Existing hyperspectral imaging systems all rely on a trade-off between spatial resolution, spectral resolution and acquisition frequency (or time resolution), this trade-off being fixed once and for all during the imager design stage. A new hyperspectral imaging device, where data acquisition can be controlled in real time has recently been demonstrated at LAAS [1]. The system takes after the "Coded Aperture Snapshot Spectral Imager" previously introduced in the literature: it is a particular assembly of a diffraction grating and a spatial light modulator (SLM) that can be controlled by software. This proposed imager can be configured by software for a given context, which yields the possibility to acquire images or sequences tailored to the perceived scene or the desired information. It has been conceived along the emerging "co-design" trend in optical systems conception, in which both the physical design and the associated processing algorithms are jointly conceived. The project therefore intricates researches on optical system conception and modelling and on data processing and control algorithms.

Internship project

The work to achieve during the internship consists in firstly specifying and dimensioning the proposed optical system, which encompasses its modelling and the consideration of calibration processes. Then, the exploitation of the system will be considered, either by developing adaptive acquisition schemes, defined by the control of the SLM, or by developing data processing algorithms adapted to the acquisition configuration. The adaptive acquisition schemes will be synthesized in real time, according to the specified information to acquire, the observed scene, and the data processing required to extract the specified information. The data processing algorithms will consist in revisiting classic hyperspectral problems (e.g. source separation, cube reconstruction, super-resolution) with the possibilities brought by an active control of the acquisition.

The work may be pursued during a PhD thesis for which a part of the grant is funded by the DGA (Délégation Générale de l'Armement). The candidate should be of French nationality.

Laboratory and contacts

The internship will be at LAAS/CNRS (Toulouse, France), and be part of a collaborative project between two research teams: Robotics and InteractionS and PHOTO.

Candidates should contact antoine.monmayrant@laas.fr and simon.lacroix@laas.fr.

References

[1] S. McGregor, A. Monmayrant, and S. Lacroix. Adaptive, hyperspectral imager: Design, modeling, and control. *Journal of Optics*, 17(8), Aug. 2015.